CLAIMS

We claim:

1. A three dimensional model re-parameterization computer system comprising:

a re-parameterization process that re-parameterizes one or more Catmull-Clark models to create a re-parameterized model, each of the Catmull-Clark models having one or more extraordinary vertices and one or more adjacent iso-parameter lines that have a natural spacing that changes, the re-parameterized model having iso-parameter lines with a new spacing that is different than the natural spacing as the lines approach the extraordinary vertex.

2. A three dimensional model re-parameterization computer system comprising:

one or more Catmull-Clark models, each of the models having one or more surfaces and one or more extraordinary vertices, where one or more adjacent iso-parameter lines have a natural spacing between them that changes as the iso-parameter lines approach the extraordinary vertex; and

a re-parameterization process that re-parameterizes the model so that one or more of the extraordinary vertices have adjacent iso-parameter lines with a new spacing that is different than the natural spacing as the lines approach the extraordinary vertex.

3. A system, as in claim 1, where the derivatives evaluated at one or more parameter values of one or more limit surfaces of subdivision of the Catmull-Clark model approach zero as one or more parameter positions approach the extraordinary vertex.

4. A system, as in claim 1, where the derivatives evaluated at one or more parameter values of a limit surface of subdivision of the Catmull-Clark model approach an actual derivative of the limit surface at the extraordinary point as one or more parameter positions approach the extraordinary vertex.

5. A system, as in claim 1, where the new spacing decreases as the iso-parameter lines approach one or more of the extraordinary vertices.

6. A method, as in claim 1, where the new spacing is uniform as the iso-parameter lines approach one or more of the extraordinary vertices.

7. A method for surface re-parameterization of a surface around extraordinary vertices of a computer three-dimensional Catmull-Clark model with a plurality of vertices, at least one extraordinary vertex, and iso-parameter lines with a natural spacing, the method comprising the step of:

re-parameterizating one or more of the subdivision surfaces of the Catmull-Clark model around one or more of the extraordinary vertices into a re-parameterized surface with a new spacing that is different than the natural spacing as the iso-parameter lines approach the extraordinary vertex.

8. A method, as in claim 7, further comprising the step of evaluating the re-parameterized surface at one or more parameter positions.

9. A method, as in claim 7, where the re-parameterizing comprises the following steps:

computing four subdominant eigenvalues corresponding to each of the vertices of a face, being face vertices, of a quadrilateral mesh containing one or more points being evaluated;

re-parameterizing the surface around each of the face vertices using a re-parameterization of vanishing derivatives, such that

$\mathbf{x} \xrightarrow{F_k} |\mathbf{x}|^{\alpha_k - 1}\,\mathbf{x}$, where k identifies the face vertex and $\mathbf{x}$ is the point being evaluated in a parameter domain, and the re-parameterization is subject to the constraint

$$\alpha_k > -\frac{\log 2}{\log \lambda_k}$$

where λ_k is the subdominant eigenvalue corresponding to face vertex k and α_k is an exponent parameter of the re-parameterization for the respective face vertex; and

blending the re-parameterizations of each face vertex that is re-parameterized.

10. A method, as in claim 7, where the re-parameterizing comprises the following steps:

computing a characteristic map corresponding to each of the vertices of a face, being face vertices, of a quadrilateral mesh containing one or more points being evaluated;

computing an inverse characteristic map for each of the face vertices; and

blending the inverse characteristic maps of the four face vertices to create the re-parameterization.

11. A method, as in claim 10, where the characteristic map is used to obtain a continuously differentiable parameterization around one or more of the extraordinary vertices.

12. A method, as in claim 10, where the inverse characteristic map is computed by locating a layer on the surface and a polynomial patch within that layer that contains the

point to be evaluated and then computing a re-parametrized position of the input point by polynomial patch inversion.

13. A method, as in claim 7, where the blending is a blending of the re-parameterizations of two or more extraordinary vertices.

14. A method, as in claim 7, where the new spacing decreases as the iso-parameter lines approach one or more of the extraordinary vertices.

15. A method, as in claim 7, where the new spacing is uniform as the iso-parameter lines approach one or more of the extraordinary vertices.

16. A system for surface re-parameterization of a surface around extraordinary vertices of a computer three-dimensional Catmull-Clark model comprising:

means for re-parameterizating of one or more subdivision surfaces of the Catmull-Clark model with a plurality of vertices and at least one extraordinary and that has iso-parameter lines with spacing that is different than an original natural spacing, as the iso-parameter lines approach the vertex.

17. A computer program product for surface re-parameterization of a surface around extraordinary vertices of a computer three dimensional Catmull-Clark model, the

computer program product having a method stored on one or more computer memory medium, the method comprising the step of:

re-parameterizating of one or more subdivision surfaces of the Catmull-Clark model with a plurality of vertices and at least one extraordinary and that has iso-parameter lines with spacing that is different than an original natural spacing, as the iso-parameter lines approach the vertex.